The limitations of simplification are evident in our lack of understanding of many of the aspects of small scale processes. As an example, while surface gravity waves have been a subject of scrutiny over the past century and a half, the fundamental processes by which they are generated and break have eluded clear description. Since it is thought that the great bulk of the air–sea transfer of heat, momentum, and moisture occurs when waves break, this lack of a basic understanding limits our ability to quantify transfer rates, a basic requirement for accurate coupled ocean–atmosphere model predictions.

Over the past few decades, considerable effort to develop innovative new means to observe small-scale processes in their detail has led to important discoveries and new insights. Fittingly, the authors begin each chapter with a presentation of the important observational results relating to particular processes, together with a brief history of the field's development and a discussion of the basic physics involved. However, I found the emphasis of the text to be on how the processes are modeled and/or parameterized in larger scale models. This is presumably a reflection of Kantha's primary research interests.

The authors clearly state that this book was not intended to be a monograph. It is not. There are texts that better present the fundamentals of internal waves (*Waves in Fluids*, by James Lighthill, Cambridge U. Press, 1978), surface gravity waves (*Dynamics and Modeling of Ocean Waves*, edited by G. J. Komen et al, Cambridge U. Press, 1994) and the effects of flow over topography (*Topographic Effects in Stratified Flows*, by Peter G. Baines, Cambridge U. Press, 1995). There is as yet no basic text that unifies the fundamental aspects of turbulence in geophysical flows—stratification, shear, rotation, and natural topography. None of the texts mentioned, however, provides the reader with such a broad and current review as is offered in *Small Scale Processes*. Its authors have done an exhaustive job of reviewing the important developments in the field, even to the extent of presenting all of the recent estimates of various phenomenological constants. While this makes the book somewhat tedious to read in places, it soon becomes clear where to skim.

Our abilities to observe small-scale processes continue to evolve at a rapid pace. This, of course, means such a review text as this is already somewhat outdated. At the time it was written, for example, there had been few hints of internal gravity wave generation over rough topography in the ocean, as the authors state. Since then, however, several research groups have shown the importance of rough topography on both mixing and the internal wave field, including important examples in the deep ocean.

The authors have done a valuable service to the community. I expect this text to be the starting point for many researchers new to a specific aspect of the field.

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Splitting the Second: The Story of Atomic Time

Tony Jones
IOP, Philadelphia, 2000.
$24.99 paper (109 pp.).
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The story of humanity's efforts to keep time with the required accuracy has not excited a high degree of popular interest. Perhaps this disinterest stems from the perception that accurate time is always available, as electricity is always there at the flip of a switch. The source of such ubiquitous phenomena as time and electricity just has not generated all that much interest. Horologists have traditionally been concerned with the design and fabrication of mechanical clocks, and philosophers deal with the nature of time. Physicists, astronomers, and engineers continue to provide and report technical developments applicable to timekeeping. But popular descriptions of timekeeping and the efforts to improve it have been rare.

In *Splitting the Second*, Tony Jones takes a step toward filling that gap, providing a very readable, popular account of the development of modern atomic timekeeping, the revolution in horology marked by the change in the basis for timekeeping from Earth's rotation to energy-level transitions within atoms. Jones begins with a short review of what he calls "Astronomers' Time." He adopts this terminology to indicate that, until relatively recently, the time of day was based solely on astronomical observations designed to refine the precision with which Earth's rotation can be measured. The contrast is with "Physicists' Time," derived from the frequency of atomic energy level transitions. To Jones, the transition from the one kind of time to the other truly represents a fundamental change in the human experience.

Splitting the Second goes on to give a comprehensive review, at a popular level, of the state of modern timekeeping. The author details the cooperation of the national timing laboratories to set an international standard time scale, including descriptions of the clocks used at these laboratories and the means by which the times provided by the clocks are combined to create the basis for all modern civil timekeeping. Jones describes the use of leap seconds, the one-second adjustments to Coordinated Universal Time (UTC), the world's standard time, to reconcile "Physicists' Time" with "Astronomers' Time." He identifies the reconciliation of the two time scales as "the problem with atomic timekeeping" and provides a clear description of this rather confusing issue.

The author's British background has apparently contributed a decidedly British perspective to the story. There is no denying the major contribution of UK scientists to modern timekeeping. British scientists were, in fact, largely responsible for developing the first operational atomic clock. However, contributions to the science of timekeeping from other national laboratories do not receive the attention they have earned.

There are some minor factual problems and some descriptions that might be considered oversimplifications. The global positioning system (GPS), while mentioned, is not properly credited for its importance in the worldwide distribution of accurate time. GPS has now become the dominant means to obtain time, even in ways of which the ultimate user is unaware. Its success and easy availability in providing time even threaten the development of new, more expensive clocks.

The author briefly describes the general concepts of one-way and two-way time transfer. In the former, the user can synchronize a clock using a "broadcast" time signal, without any interaction with the signal provider. In the latter, the user must interact with the provider. Jones details the use of common-view time transfer in the formulation of the Coordinated Universal Time. However, he has left out the use of two-way satellite time transfer, a technique that makes an important contribution to the formation of UTC.

In summary, *Splitting the Second: The Story of Atomic Time* is an interesting, readable account of the state of modern timekeeping. It is not comprehensive and is not the definitive history of this stage of the human attempt to provide accurate timekeeping. It is, however, a good introduction and well worth reading by those interested in this rather poorly documented area of modern science and technology.

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Silicon Surfaces and Formation of Interfaces: Basic Science in the Industrial World

Jarek Dąbrowski and
Hans-Joachim Müssig
World Scientific, River Edge, N.J., 2000. $68.00 (550 pp.)
ISBN 981-02-3286-1

Silicon Surfaces and Formation of Interfaces, by Jarek Dąbrowski and Hans-Joachim Müssig provides a welcome look at the basic sciences of silicon surfaces for the requirements of the fast-paced microelectronic industry. The industry is of enormous importance to communication and information infrastructures. The technology has now reached a level where atomic control of interfaces is a critical requirement for its future generations. Therefore, a wide range of engineers must be aware of the tools and methods that are at their disposal for characterizing and understanding the formation of interfaces, particularly in silicon-based devices. Conversely, surface scientists should learn about technological issues that are likely to benefit from their expertise. The tutorial nature of *Silicon Surfaces and Formation of Interfaces* makes it an insightful resource for both communities.

In the introductory chapter, the authors make a convincing case for the importance of fundamental surface science studies in silicon processing, which, unlike a field like catalysis, thrives on two-dimensional order and atomic perfection at interfaces, making silicon technology fully compatible with surface science techniques.

Dąbrowski and Müssig devote three early chapters to background, including structural and dynamical properties of clean silicon surfaces. This historical description is fascinating, if not concise, and these chapters contain important basic and quantitative information that is nicely summarized in tables and figures. Many readers may skip the details of the controversies that characterized the early days of silicon surface science to focus on the current understanding of clean sur-